EFFECTIVE AIR QUALITY MONITORING SYSTEM WITH PMS7003

Dr. MOHANRAJ M
Electrical and Electronics Engineering
Kumaraguru College of Technology
Coimbatore, India
mohanraj.m.eee@kct.ac.in

SIVANITHISH R K
Electrical and Electronics Engineering
Kumaraguru College of Technology
Coimbatore, India
sivanithish.20ee@kct.ac.in

ROJA K
Electrical and Electronics Engineering
Kumaraguru College of Technology
Coimbatore, India
roja.20ee@kct.ac.in

SHREE BRAMMAGIRI N
Electrical and Electronics Engineering
Kumaraguru College of Technology
Coimbatore, India
shreebrammagiri.20ee@kct.ac.in

Abstract **- The disposal and separation of waste materials in dumping yards often exposes workers to hazardous airborne pollutants, leading to respiratory and health issues. This project presents an innovative solution to address these challenges by developing an integrated air quality monitoring system for waste sorting facilities. The primary objective is to continuously assess the quality of the air within these facilities and provide real-time alerts to workers when air quality deteriorates beyond predefined thresholds. The system utilizes a network of sensors to monitor various air quality parameters, including particulate matter, volatile organic compounds, and gases emitted during waste incineration and other waste-related activities. Collected data is transmitted to a cloud-based platform for storage, analysis, and future reference. This project not only offers a means to safeguard the health and well-being of waste facility workers but also contributes to the long-term environmental sustainability of waste management processes. The results of this study demonstrate the feasibility and effectiveness of implementing an integrated air quality monitoring system to mitigate health risks and improve the overall working conditions within waste sorting facilities.**

Keywords: Air quality, ESP8266, PMS7003, THINKSPEAK, cloudqw

I. INTRODUCTION

Air pollution affects our day-to-day activities and quality of life. It poses a threat to the ecosystem and the quality of life on the planet. The dire need to monitor air quality is very glaring, owing to increased industrial activities over the past years [1]. Air pollution occurs when toxic or harmful substances including gases, dust particles and biological molecules are introduced into Earth's atmosphere. It is caused by the rapid increasing and development in industrial evolution and transportation, air contamination has recently become a serious problem for developing countries. It is one of the major issues in the atmosphere. Air contamination should be controlled in order to overcome life threatening diseases like cancer, respiratory diseases and much more which are faced by human beings. Air pollution Monitoring System is designed using Node MCU and air quality sensors. The automation is done using these hardware components, which enables wireless communication and can control the behavior of sensors. The Node Microcontroller Unit is responsible for controlling sensors such as Temperature and Humidity sensors, Air quality Sensors and Gas Sensors. Node MCU sends signals to each sensor to perform specific action or retrieve data from a specific sensor. The data sent from the microcontroller is sent to the ThingSpeak cloud [2]. The Internet of Things (IoT) is nowadays finding profound use in each and every sector and plays a key role in our air quality monitoring system too. Our setup will show the air quality in PPM (Parts per Million) in a web page so that we can monitor it very easily. In this IoT project, one can monitor the pollution level from anywhere using a computer or a mobile [3]. Sustainable growth of the whole world depends on several factors such as economy, quality education, agriculture, industries and many others, but environment is one of the factors that plays the most important role.

Health and hygiene are key components of the sustainability of mankind and progress of any country, which comes from a clean, pollution-free and hazardous free environment. Thus, its monitoring becomes essential to ensure that the citizens of any nation can lead a healthy life [5]. Addressing the safety of waste separation workers, this project offers a vital solution through alert signals triggered when threshold levels are reached. Tailored to the specific needs of individuals working in waste separation yards, the system ensures timely warnings about atmospheric pollutant levels. The integration of alert signals enhances the overall safety measures, creating a proactive and responsive environment for workers. By focusing on real-time monitoring and immediate alerts, the project aims to

significantly reduce health risks and improve the overall well-being of those employed in waste separation activities.

II. LITERATURE SURVEY

LITERATURE REVIEW 1:

The system under review, built on the Arduino microcontroller platform, is designed to perform real-time monitoring and analysis of air pollution. It incorporates an MQ135 sensor for quantifying air quality in terms of Parts per Million (PPM), with the results displayed on an LCD screen. A notable feature of this system is its capacity to send data to a remote server via a Wi-Fi module, utilizing the "ThingSpeak" platform, thereby enabling access to real-time air quality data on a global scale. This system offers not only immediate data visualization but also serves as a tool for promoting awareness of air quality, making it a valuable asset for environmental monitoring and public health, with opportunities for further advancement in future research and development.

LITERATURE REVIEW 2:

Air pollution, a result of industrial and transportation growth, particularly impacting developing nations, poses severe health risks. An Air Pollution Monitoring System using Node MCU and air quality sensors offers a wireless, automated solution. It monitors pollutants in areas with waste accumulation, contributing to air pollution. The system is cost-effective for integration into existing infrastructures, comprehensively monitoring CO2, Smoke, LPG, Temperature, Humidity, SO2, NO2, and Alcohol. Data is sent to the ThingSpeak cloud platform, which aids in real-time pollution data visualization through a mobile app and enables cloud-based analysis for identifying pollution sources and implementing preventive measures.

LITERATURE REVIEW 3:

Air pollution, driven by industrial emissions, vehicle exhaust, and urbanization, poses significant health risks. Real-time air quality monitoring is crucial for informed decision-making, and the paper introduces a standalone system with Internet of Things (IoT) integration. It presents air quality data in Parts per Million (PPM) on a web page, making it accessible from various devices. Challenges related to vehicle emissions and pollution intensity are discussed, along with IoT's role in data transmission and remote access. Visualizations of air quality data and Linear Regression for data analysis are presented. The paper highlights the use of MQ135 and MQ7 sensors to detect specific gases and addresses indoor and outdoor monitoring using sensor networks. It emphasizes the importance of sensor calibration and the potential for applying machine learning techniques in data analysis for improved air quality.

III. PROBLEM STATEMENT

Workers in waste segregation confront a pressing issue as pollution from waste incineration jeopardizes their well-being. The emissions from incineration processes pose health risks, creating an unsafe working environment. This pollution adversely affects air quality, impacting the respiratory health of workers. Additionally, the hazardous byproducts may lead to long-term health issues. Mitigating this problem is crucial for safeguarding the workers' health and ensuring a sustainable waste management process. Addressing the pollution challenges requires strategic measures to enhance workplace safety, promoting a healthier environment for those involved in waste segregation activities.

IV. PROPOSED SYSTEM

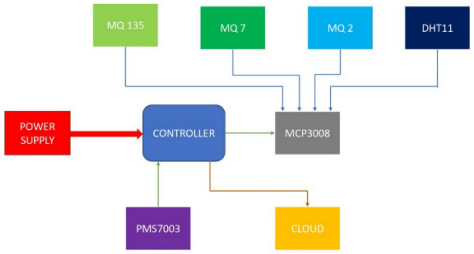

Fig.1. Proposed flow diagram

Fig. 1 shows the flow diagram of the proposed system and fig. represents the proposed circuit diagram for simulation.

In waste segregation environments, workers frequently face health challenges attributed to heightened pollution resulting from incineration processes and the release of gases from waste materials. In response to this critical concern, we have developed an innovative air quality monitoring device. This device incorporates essential sensors, including the PMS3007 for monitoring particulate matter, the DHT11 for tracking temperature and humidity, and gas sensors MQ135, MQ2, and MQ7.

The primary objective of this system is to proactively address the health risks faced by workers in waste segregation facilities. The integrated sensors work collaboratively to assess air quality parameters, ensuring a comprehensive evaluation of the surrounding environment. The device is designed to sound an alarm when air quality levels exceed predefined thresholds. This real-time alert system serves as a crucial tool, offering timely notifications to workers, enabling them to stay informed about the prevailing air quality conditions.

V. COMPONENTS

1. MQ 135

Fig.2 MQ 135 sensor

Fig.2 illustrates the MQ-135 Gas sensor, designed for air quality control applications. It can detect or measure various gases, including NH3, NOx, Alcohol, Benzene, Smoke, and CO2. The sensor module features a Digital Pin, enabling standalone operation without a microcontroller, which is useful for single gas detection. For PPM measurements, the analog pin, TTL driven and compatible with 5V, is employed. This makes it suitable for most common microcontrollers. If you require a sensor for detecting prevalent air quality gases like CO2, Smoke, NH3, NOx, Alcohol, and Benzene, the MQ-135 sensor is a practical choice.

2. MQ-7 GAS SENSOR

Fig.3 MQ-7 sensor

The MQ-7 Semiconductor Sensor in the above fig.3 for Carbon Monoxide utilizes a sensitive material, SnO2, with lower conductivity in clean air. It employs a temperature cycling method to detect CO at low temperature (heated by 1.5V), with higher conductivity as gas concentration rises. At high temperature (heated by 5.0V), it cleans gases adsorbed under low temperature. By incorporating a simple circuit, the change in conductivity is converted into a corresponding output signal representing gas concentration. Known for its high sensitivity to Carbon Monoxide, the MQ-7 sensor is cost-effective and suitable for diverse applications, capable of detecting various gases containing CO. The sensor's performance relies on the chemiresistor, Tin Dioxide (SnO2), which has free electrons attracted by oxygen molecules, affecting output current based on the availability of free electrons in SnO2.

3. MQ-2 GAS SENSOR

Fig.4 MQ-2 sensor

The Gas Sensor (MQ2) module in fig.4 proves valuable for detecting gas leaks in both home and industrial settings, capable of identifying H2, LPG, CH4, CO, Alcohol, Smoke, or Propane. Its rapid response time, coupled with high sensitivity, enables swift measurements. Adjusting the sensor's sensitivity is possible through a potentiometer. The sensor incorporates an Anti-explosion network, consisting of two layers of fine stainless-steel mesh, to prevent potential explosions when sensing flammable gases. This network also acts as protection for the sensor, filtering out suspended particles, allowing only gaseous elements to enter the chamber. The mesh is securely connected to the rest of the body using a copper-plated clamping ring.

4. MCP3008 Module

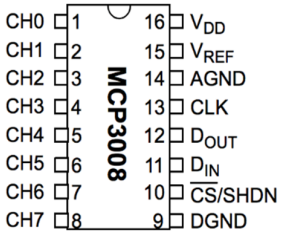

Fig.5 Pin configuration of MCP3008

The MCP3008 IC Module in fig.5, is developed in collaboration with Microchip Technology, serves as an analog-to-digital conversion (ADC) integrated circuit. It establishes a connection with microcontrollers or single-board computers (SBC) through the Serial Peripheral Interface (SPI), facilitating the conversion of analog signals into digital format. With a 10-bit resolution, the MCP3008 IC enables the module to accurately convert analog signals, producing digital values within the range of 0 to 1023.

5. PMS7003 Particulate matter sensor

Fig.6 PMS7003 Particulate matter sensor

The PMS7003 in the above fig.6 is a digital and versatile particle concentration sensor designed to measure the quantity of suspended particles in the air. It provides particle concentration data through a digital interface, making it suitable for integration into various instruments related to air particle concentration or environmental improvement devices. This sensor ensures real-time and accurate concentration data, contributing to effective monitoring and enhancement of air quality.

6. DHT11 sensor

Fig.7 DHT11 sensor

The DHT11 sensor in the above fig.7 serves as an economical digital sensor designed for temperature and humidity sensing. It seamlessly interfaces with various microcontrollers, including Arduino and Raspberry Pi, enabling instantaneous measurement of humidity and temperature. Available in both sensor and module forms, the distinction lies in the inclusion of a pull-up resistor and a power-on LED in the module. Functioning as a relative humidity sensor, the DHT11 utilizes a thermistor and a capacitive humidity sensor to measure the ambient air conditions accurately.

VI. WORKING

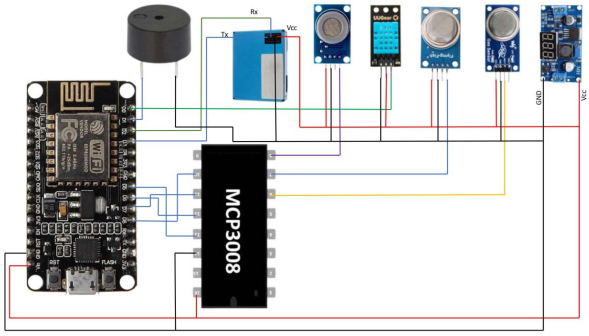

Fig.8 Circuit Diagram

Fig.8 represents the proposed work consisting of a group of gas sensors such as MQ-7, MQ-2 and MQ-135.We have also used DHT11 sensor for temperature and humidity sensing. The plantpower7003 pms sensor for sensing the PM1.0, PM2.5 and PM10.NodeMCU(ESP8266) is used as a primary controller for this work. We use mcp3008 analog to digital conversion module to convert all analog signals into digital signals. NodeMCU can have only one input as an analog. NodeMCU (ESP8266) is programmed in a way that the values of each sensor will shared to the cloud platform which we were created using Thinkspeak. The cloud platform enables us to see the visualized data of each sensor in a particular interval time in a graphical format. If any one of these sensors data exceeds the threshold values, The buzzer will give an alarm.

These sensors will measure various air quality parameters such as particulate matter, carbon monoxide, smoke, Ammonia, sulfur, CO2 and benzene. MCP3008 is an ADC which acts as an interface between sensors analog output and NodeMCU's digital input. NodeMCU receives data from the sensors, processes it and it sends to the cloud server.

The proposed project involves the integration of multiple gas sensors, including MQ7, MQ2, and MQ135, alongside a DHT11 sensor for temperature and humidity, and a Plantpower7003 PMS sensor for measuring PM1.0, PM2.5, and PM10. The primary controller for this system is the NodeMCU (ESP8266), which utilizes an MCP3008 analog-to-digital conversion module to convert analog signals from the sensors into digital format. Since the NodeMCU supports only one analog input, the MCP3008 acts as an interface, facilitating the conversion of multiple analog signals.

The NodeMCU is programmed to collect data from each sensor, and these values are transmitted to a cloud platform created using ThingSpeak. This cloud platform enables users to visualize the sensor data at specified intervals in a graphical format. Additionally, an alarm system, triggered by a buzzer, is incorporated into the project. If any of the sensor readings surpass predefined threshold values, the buzzer will sound the alarm.

The sensors employed in this project measure various air quality parameters, including particulate matter, carbon monoxide, smoke, ammonia, sulfur, CO2, and benzene. The

MCP3008 plays a crucial role in interfacing these sensors with the NodeMCU, facilitating the conversion of analog signals to digital for further processing. The NodeMCU acts as both a data processor and transmitter, sending the processed sensor data to the cloud server for visualization.

By implementing this monitoring technology, we strive to empower waste segregation workers with the knowledge they need to protect their health. The alarm system acts as a preventive measure, allowing workers to take necessary precautions when pollution levels reach critical points. Ultimately, this initiative aims to significantly improve the overall well-being of workers in waste segregation activities by providing a proactive and responsive solution to the challenges posed by elevated air pollution levels.

VII. RESULTS AND DISCUSSIONS

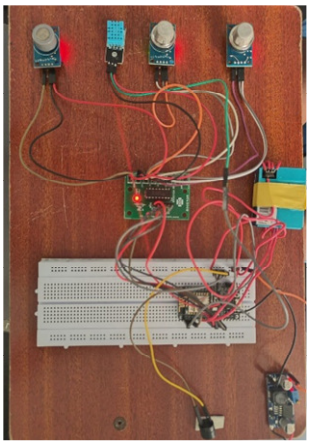

Fig.9 Implementation of hardware

Fig.10 Results Obtained

From the circuit diagram fig.8, the result is obtained that looks like in fig.10. From Fig.9, it can be seen that all sensors have been connected to the ESP8266 controller.

The results show that the device shows measurements of temperature, humidity, dust particles, and levels of polluting gases (Particulate matter, CO2, Benzene, NH3, Alcohol, CO, LPG and Methane), as shown in Figure 10. Besides, we also send measurement data to the ThingSpeak Cloud using the WiFi module on the ESP8266. The results that appear on the ThingSpeak Cloud can be seen in Fig.10.

VIII. CONCLUSION

In conclusion, the advanced system, equipped with NodeMCU, MQ4, DHT11, MQ7, and PMS sensors, prioritizes worker well-being in waste separation environments. It proactively alerts when air pollutant levels exceed thresholds, while the DHT11 sensor provides a comprehensive understanding of temperature and humidity. Specialized sensors detect methane, monitor carbon monoxide, and measure particulate matter, ensuring adherence to occupational health standards. This holistic approach mitigates respiratory risks and creates a safer work environment. Real-time monitoring enhances efficiency, making it a valuable tool for advancing health and safety in waste management practices.

IX. FUTURE SCOPE

Our upcoming initiative involves introducing an innovative air purifier, stemming from a strategic understanding of the need for comprehensive air quality management. The purifier utilizes cutting-edge filtration and smart sensors for real-time adjustments, aiming to enhance indoor air quality dynamically. Key features include intelligent pollutant detection, adaptive purification settings, and a user-friendly interface. Emphasizing innovation in design, energy efficiency, and scalability, the project aligns with our commitment to addressing air pollution for positive societal impact. This venture represents a pivotal step toward sustainable and health-conscious solutions, aiming to anticipate and adapt to future challenges in air quality management.

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